GUAM AGRICULTURAL EXPERIMENT STATION

ISLAND OF GUAM

Under the supervision of the

UNITED STATES DEPARTMENT OF AGRICULTURE

REPORT OF THE GUAM AGRICULTURAL EXPERIMENT STATION

1925

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GUAM AGRICULTURAL EXPERIMENT STATION, ISLAND OF GUAM

[Under the supervision of the Office of Experiment Stations, United States Department of Agriculture]

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[1] Appointed February 16, 1925.

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REPORT OF THE DIRECTOR

By C. W. Edwards

During the fiscal year 1925 crop production throughout the island was seriously interfered with by unfavorable weather. A period of excessive rainfall during the wet season was followed by the longest drought experienced on the island in many years. A near-by typhoon during early August caused unusually heavy rains, and a light typhoon passing over the island October 1 was accompanied in various districts by the heaviest rainfall recorded on the island. The precipitation officially recorded in Agaña was 19 inches in 15 hours, 28.25 inches in 30 hours, and 33.09 inches in 48 hours, whereas that in the Piti district was only 16.31 inches for the 48-hour period.

Because of the lack of special extension employees, members of the station staff were compelled to devote considerable time to field work, responding to calls for advice on various farm problems and investigating plant and animal diseases. The regular station duties demand the entire time of the staff and the need of an extension agent and assistants is keenly felt. The results accomplished by the extension agent during two years (1919 and 1920) are ample proof of the great value of extension work to the agricultural development of the island. The proper dissemination of information resulting from the investigational work at the station can be accomplished only through the activities of an extension agent and his assistants.

The appropriation of $8,000, made by Congress in December, 1924, for coconut scale control work, enabled the appointment to the station staff of an entomologist, the construction of an insectary, and the purchase of necessary equipment for use in combating the pest. It is hoped that funds will be provided so that the entomologist may be retained after the period covered by the deficiency allotment expires. The station personnel should include an entomologist

who can devote his time to study of the many serious plant pests prevalent on the island and also act as inspector of importations and exportations of plant material to safeguard agricultural interests.

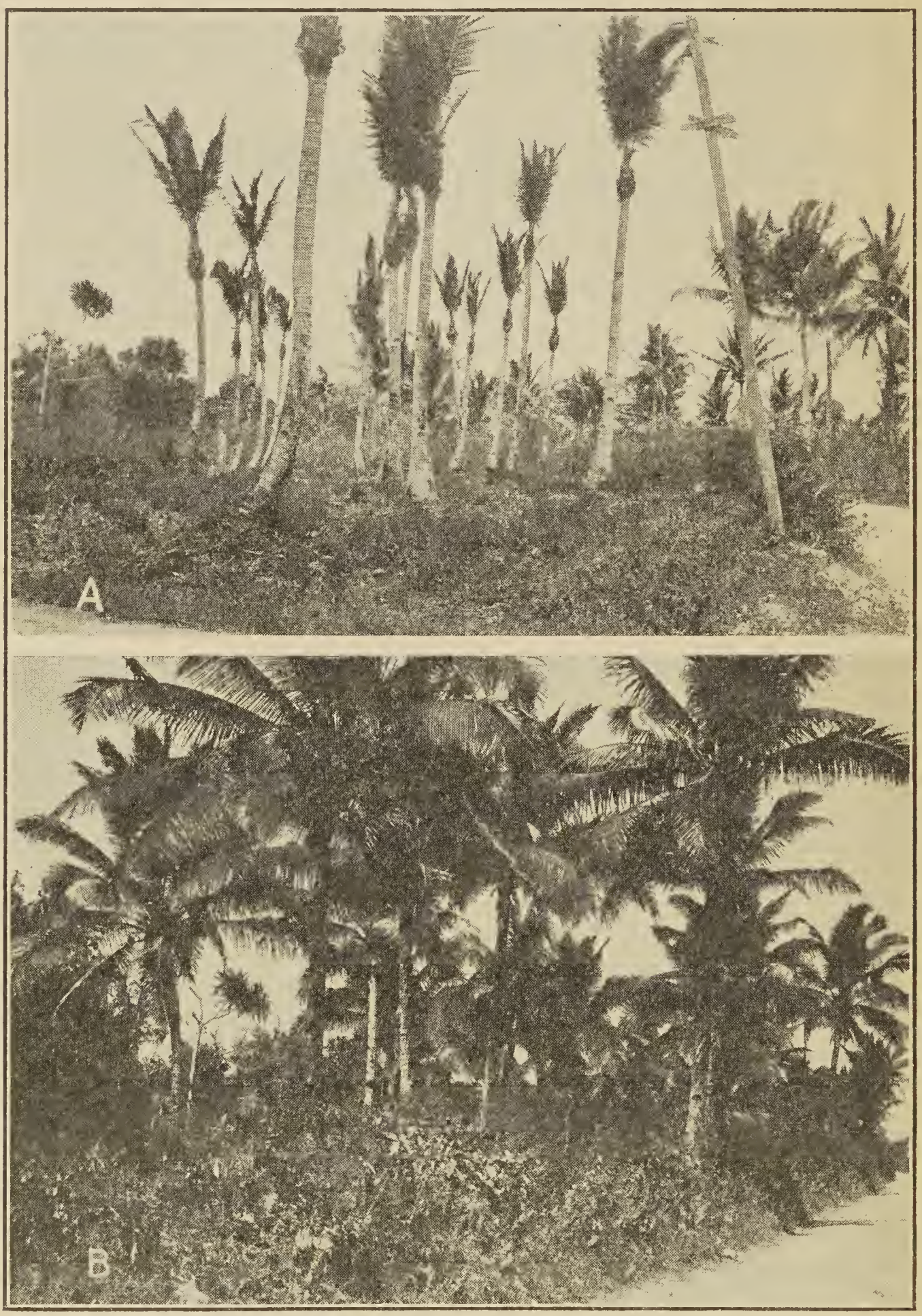

FIG. 1.—A. Coconut trees severely pruned for control of *Aspidiotus destructor*, 1924. B. Portion of same grove in 1925, showing recuperation of trees

Insect pests of plants were less troublesome than in some years. The coconut scale (*Aspidiotus destructor*), which was largely confined to the northern part last year, was found to have spread over the

greater part of the island. A large portion of the area, however, carried only light infestation, and there were fewer severely infested areas than was the case the previous year. On the whole, the situation was less alarming than formerly, apparently on account of parasitism and the emergency control measures adopted at the time the pest was discovered. These measures consisted in cutting and burning the lower or most heavily infested leaves of the coconuts and cleaning up undergrowth in the most severely attacked areas, and seemed to offer a decided check to the progress of the scale; and the severe pruning, although followed by a long drought, did less injury to the trees than was anticipated (fig. 1, A, B). The entomologist, in addition to making a survey of the coconut-scale situation and attending to other duties, gave talks on insect pests and methods of control before various representative bodies.

FIG. 2.—Normal school class instructed in agriculture

The station cooperated with the department of public instruction in carrying on agricultural work in the various schools. Members of the staff gave a series of lectures before the normal school classes of island teachers (fig. 2), and acted as judges of the school-garden exhibits. A plat of ground and agricultural equipment were loaned by the station to the agricultural classes of the Piti school, and suggestions relative to their work were given (fig. 3).

ANIMAL HUSBANDRY

PASTURAGE

As the result of prolonged drought and extensive savanna fires during the year, there was a general shortage of upland native-grass pasturage for several months. The practice of burning uplands is discountenanced by the station. The area may possibly be improved for pasture purposes provided the ground is not too dry and

rains closely follow the burning, but usually it kills the stand of grass and results in a growth of mumutong (*Cassia occidentalis*) or other weeds, and not infrequently destroys the growth of ironwood (*Casuarina equisetifolia*).

Swine

The island has been free from hog-cholera and other serious diseases for three years, and the animals which were lost in the cholera outbreak of 1922 are gradually being replaced. Some loss from internal parasites is sustained each year, due largely to not knowing how to handle the animals. Farmers are urged to make a more general use of the movable colony houses and pens to overcome loss from this source. During the year the station devised a type of house which seems to be well suited for use under local conditions (fig. 4).

Fig. 3.—Spraying demonstration, agricultural school

Many of the local farmers are beginning to appreciate the value of coconut meal as a feed for livestock, but others still regard the product with suspicion and even with prejudice. A sample of coconut meal analyzed by the Bureau of Chemistry, United States Department of Agriculture, showed the following composition:

Table 1.—*Composition of coconut meal*

Proximate constituents	Per cent
Moisture	9.30
Ash	6.25
Ether extract	8.38
Protein	23.91
Crude fiber	10.25
Nitrogen-free extract	41.91
Total	100.00

To determine whether coconut meal is injurious when fed to pigs, and to obtain data on the comparative efficiency of feeds and the relative proportion of each consumed, the station conducted a series of feeding tests with pigs during the year (fig. 5).

TESTS OF COCONUT MEAL AND OTHER FEEDS

Test No. 1. Coconut meal (local), cracked corn, and tankage for young pigs.—Nine females (4 one-half Duroc-Jersey, fifteen thirty-seconds Berkshire, and one thirty-second native, 85 days old, and 5 one-half Duroc-Jersey, seven-sixteenths Berkshire, and one-sixteenth native, 80 days old), averaging 31.22 pounds in weight at the beginning of the test, were placed on a ration (fed free choice from self-feeder) consisting of coconut meal, cracked corn, and tankage, supplemented with all they would eat of a mineral mixture

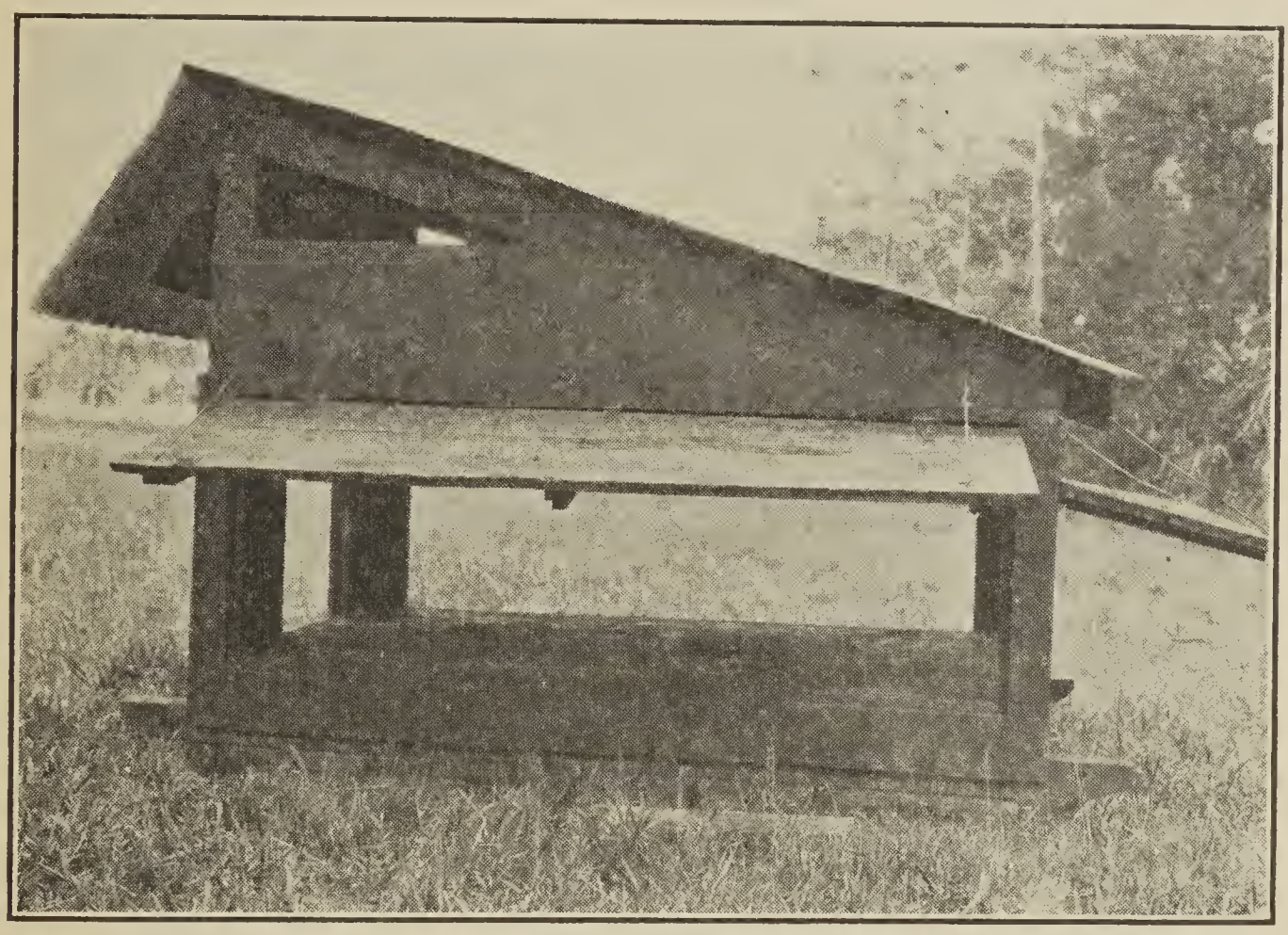

FIG. 4.—Guam type colony house for pigs

composed of 50 parts by weight of wood ashes, 30 parts finely ground local limestone (cascajo), and 20 parts salt, during a period of 45 days (January 3 to February 17). The lot was kept in a colony pen having free access to the self-feeder and were fed fresh Para grass daily. They took only an insignificant quantity of the mineral mixture, probably on account of lack of palatability and the fact that the run contained much surface limestone. The animals were fed the trial ration for 15 days preceding the test.

The lot made a total gain of 379 pounds, or an average daily gain of 8.422 pounds, and consumed 979 pounds of feed (497 pounds corn, 362 pounds copra meal, and 120 pounds tankage) at the rate of 21.756 pounds per day (11.04 pounds corn, 8.04 pounds coconut meal, and 2.66 pounds tankage). Each pig daily consumed 2.417 pounds of feed, and made an average daily gain of 0.936 pound. A total of 258 pounds of feed was required to produce 100 pounds of

gain. Determination of the proportion of feeds consumed showed that 1 part by weight of coconut meal was eaten to 1.373 parts corn, or to 1.704 parts corn and tankage, and that 12.25 per cent tankage was used to 50.77 per cent corn and 36.98 per cent coconut meal. The corn cost $19.88 (4 cents a pound), the coconut meal $4.53 (1¼ cents a pound), and the tankage $6 (5 cents a pound), making the total cost of the feed $30.41. The cost of the feed per 100 pounds of gain was $8.02, or 8 cents per pound of gain.

Test No. 2. Coconut meal (local), and mineral mixture for growing pigs.—An 80-day test (March 7 to May 26) was carried on with 5 boars (3 one-half Duroc-Jersey, fifteen thirty-seconds Berkshire, and one thirty-second native, 148 days old, and 2 one-half Duroc-

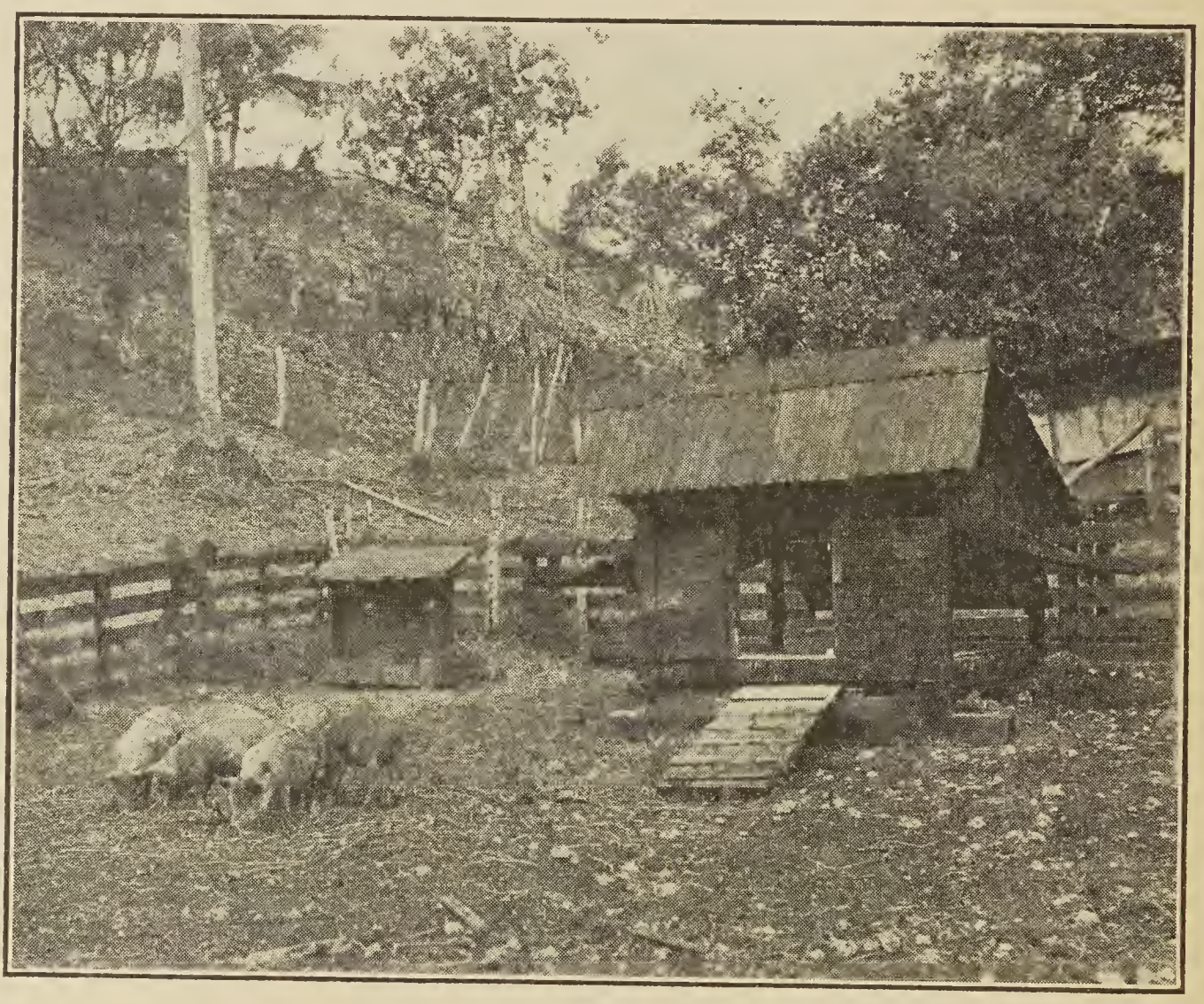

FIG. 5.—Type of house and runs used in feeding experiments

Jersey, seven-sixteenths Berkshire, and one-sixteenth native, 143 days old), averaging 84.43 pounds in weight at the beginning of the test. The lot was placed on Para grass and had free access to the self-feeder containing coconut meal and the mineral mixture described in test No. 1. During the 45 days following weaning, the pigs were fed all they would eat of a ration consisting of ground corn, coconut meal, and tankage, and from the close of the period to the beginning of the test they had free access to ground corn and coconut meal.

The lot made a total gain of 449 pounds or an average daily gain of 5.62 pounds, and consumed 1,540 pounds coconut meal and 8.5 pounds mineral mixture. Each pig made an average daily gain of 1.12 pounds. A total of 343 pounds of feed was required to produce 100 pounds of gain. The total cost of the coconut meal was $19.25 (1¼ cents a pound). The cost of the feed per 100 pounds of gain

was $4.28, or 4.28 cents per pound of gain. The runs in test No. 2 contained practically no surface limestone.

Test No. 3. Cracked corn and coconut meal (local) for young pigs.—Four barrows and 2 females (one-half Duroc-Jersey, fifteen thirty-seconds Berkshire, and one thirty-second native) 83 days old, and averaging 29 pounds in weight at the beginning of the test, were kept in colony pens during a period of 80 days (February 25 to May 16), and given free access to the self-feeder containing cracked corn and coconut meal and a mineral mixture made up of wood ashes, lime, and salt to compare the results obtained with those of test No. 1, in which pigs of similar age and breeding were fed tankage, supplemented with corn and coconut meal. The pigs were fed the trial ration for 15 days preceding the test. The lot made a total gain of 278 pounds, or an average daily gain of 3.477 pounds, and consumed 825 pounds of feed (450 pounds corn, 375 pounds coconut meal), but only a slight amount of mineral mixture. The lot made an average daily gain of 0.579 pound per head. A total of 296.76 pounds of feed was required to produce 100 pounds of gain. The corn cost $18 (4 cents a pound), and the coconut meal $4.69 (1¼ cents a pound), making the total cost of the feed $22.69. The cost of the feed per 100 pounds of gain was $7.26, or 7.3 cents per pound of gain.

Test No. 4. Coconut meal (local) and cracked corn for growing pigs.—The lot of grade females previously used in test No. 1, 4 females 130 days old, and 5 females 125 days old, and averaging 73.3 pounds in weight at the beginning of the test, were placed in colony pens during a period of 60 days (February 17 to April 18), and allowed free choice from self-feeder of a ration consisting of coconut meal and cracked corn. In addition they were allowed to run daily on fresh Para grass and given free access to the self-feeder. The lot made a total gain of 585.5 pounds or an average daily gain of 9.75 pounds, with an average daily gain per head of 1.08 pounds, and consumed 2,120 pounds of feed (1,200 pounds corn, and 920 pounds coconut meal), at the rate of 35.33 pounds per day (20 pounds corn, and 15.33 pounds coconut meal). A total of 362 pounds of feed was required to produce 100 pounds of gain. The corn cost $48 (4 cents a pound), and the coconut meal $11.50 (1¼ cents a pound), or $59.50 altogether. The cost of the feed per 100 pounds of gain was $10.16, or 10.2 cents a pound.

Comments on the tests.—A comparison of the results of test No. 1 (fig. 6, A) with those of test No. 3 indicates the value of tankage as a feed for pigs during at least a period following weaning. The lot in test No. 3 made a slightly more economical gain than did the lot in test No. 1, but the animals exhibited marked individual variation, and the growth of at least two of them was so checked as to interfere with later development (fig. 6, C).

The results of test No. 2 show that no harm followed when coconut meal constituted the entire concentrate ration (fig. 6, B). In fact, the lot made surprisingly good gains at low cost and were in good condition at the close of the test. One pig made a gain of a pound per day. Although it probably would not be advisable to feed coconut meal alone to pigs of all ages or for long periods, the results accomplished show the possible range of value of the product as a feed.

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It will be noted that the lots having free access to corn and coconut meal consumed a greater proportion of the latter than is generally recommended.

The feed in each case was listed at the prevailing average market price. Under present methods of production locally grown corn equals in price

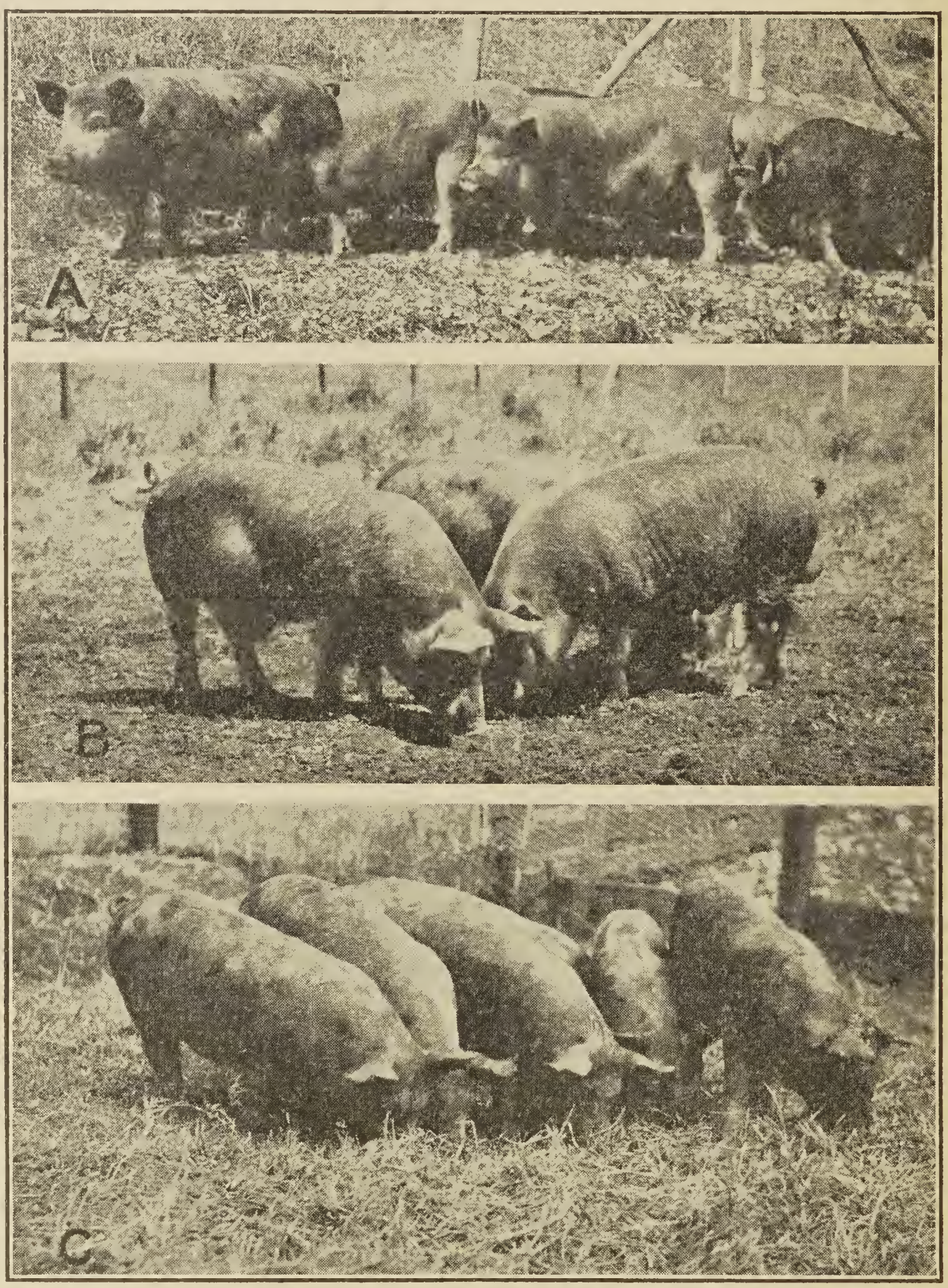

FIG. 6.—Pig-feeding experiment. A. Test 1, pigs fed coconut meal, cracked corn, and tankage. B. Test 2, pigs fed coconut meal. C. Test 3, pigs fed cracked corn and coconut meal

the imported article. The pigs in the test made exceptionally good gains for grade animals, but at a comparatively high cost, showing that corn on the local market is an expensive feed for pigs. Either the cost of production must be reduced by the adoption of more modern methods, or other more economical ration combinations must be used.

REPORT OF THE ASSISTANT IN AGRONOMY AND HORTICULTURE

By Joaquin Guerrero

FORAGE CROPS

Paspalum dilatatum.—The area in *Paspalum dilatatum* was extended during the year, an acre-plat being planted at Piti and approximately 8 acres at Cotot. In one planting where the roots were set 6 inches apart each way the grass covered the ground within 30 days and required only one cultivation, whereas in another planting where the roots were spaced 18 inches apart, approximately 90 days elapsed before the growth filled the spaces between rows and three cultivations were necessary. On account of the much greater cost, close planting is not recommended except possibly where the area is small and an intensive system is followed.

Fig. 7.—Adaptability tests of forage plants. Left to right, Japanese cane, Napier, Guatemala, Merker, and *Pennisetum setosum*, 243 days after planting

Adaptability tests.—In continuation of investigations dealing with the adaptability of introduced forages to the different local soils, a planting of Japanese cane, Napier, Guatemala, Merker, and *Pennisetum setosum* grasses was made at the station in November, 1924. The soil on which the plats are located is a very thin clay loam underlain by limestone, and is similar in nature to that of many of the areas of the northern part of the island. The planting was followed by a short period of light rains and then by a protracted drought, which permitted of observing the comparative drought-resistant qualities of the grasses the first season. Napier and Guatemala grasses made the best showing, followed by Merker and *P. setosum* grasses and Japanese cane, in the order named (fig. 7).

Fertilizer tests.—Two cuttings of Guatemala grass and Japanese cane, and three of Napier grass were obtained in the fertilizer test begun last year (figs. 8, 9, and 10).

The plat receiving the lime treatment again produced the highest yield of Guatemala grass, and those treated with lime and manure in combination gave the highest yields of Napier grass and Japanese cane. Table 2 shows the yields secured from the cuttings made during the year.

FIG. 8.—Fertilizer experiments with Napier grass. Left to right, lime, manure, and lime and manure, 213 days after third cutting

TABLE 2.—*Fertilizer test with coarse forages planted October 25, 1923*

Forage crop	Treatment per acre	Height	Yield per acre			Total
			First cutting	Second cutting	Third cutting	
		Inches	*Tons*	*Tons*	*Tons*	*Tons*
Napier grass	Lime (2 tons); manure (10 tons)	96.0	12.5	22.5	11.5	46.5
Do	Manure (10 tons)	87.8	8.5	13.5	10.0	32.0
Do	Lime (2 tons)	88.8	12.0	15.5	7.0	34.5
Guatemala grass	Lime (2 tons); manure (10 tons)	62.6	6.2	13.0	----	19.2
Do	Manure (10 tons)	68.2	9.2	14.0	----	23.2
Do	Lime (2 tons)	71.2	8.0	17.5	----	25.5
Japanese cane	Lime (2 tons); manure (10 tons)	95.6	25.0	16.0	----	41.0
Do	Manure (10 tons)	87.4	15.4	18.5	----	33.9
Do	Lime (2 tons)	90.2	16.2	19.0	----	35.2

Molasses grass (Melinis minutiflora).—A one-fourth acre plat from which unsuccessful attempts had repeatedly been made to exterminate Johnson grass, was planted with molasses grass in June, 1924. The stand made good growth, flowered profusely in November, and kept the Johnson grass well in check (fig. 11). Two cuttings were obtained from the area. The first, made February 6, 1925, yielded at the rate of 24.88 tons of green forage per acre, and the second, made June 11, 1925, 8.6 tons per acre.

LEGUMES

Alfalfa (*Medicago spp.*).—Seed of the varieties Hunter River, Chinese, and Province, received from South Africa during the year, was inoculated and sown in drills in March. The resulting plants

FIG. 9.—Fertilizer experiments with Guatemala grass. Left to right, lime, manure, and lime and manure, 213 days after second cutting

were about 18 inches high and starting to seed at the close of the year. These varieties made fairly good yields of forage in a former test, but failed to seed.

Kudzu (*Pueraria thunbergiana*).—Former plantings of both the large-leaf and the small-leaf varieties of kudzu failed to make satisfac-

Fig. 10.—Fertilizer experiments with Japanese cane. Left to right, lime, manure, and lime and manure, 213 days after second cutting

tory growth on lowland clay soil. The small-leaf variety was planted last year on cascajo soil hillsides, but after 18 months, during which time the plat was kept clean, the stand was unable to keep down weed and other volunteer growth, and showed to marked extent the ill

effects of drought (fig. 12). After the rains began at the close of the year the crop was making better growth than at any former period.

FIG. 11.—Molasses grass, 11 months after planting. Dense growth which held Johnson grass in check

FIG. 12.—Kudzu on cascajo hillside, 24 months from planting and after 18 months cultivation. Lower portion cleared to show growth of vine

Tephrosia spp.—*T. hookeriana* and *T. candida*, grown from seed obtained from the Philippines, are doing well and give indications of becoming valuable cover crops for the island. *T. hookeriana* in

two cuttings yielded approximately 12.5 tons per acre of green roughage, and *T. candida* 20 tons per acre.

Cover crop efficiency test.—Cover crop investigations were continued with velvet, Patani and mungo beans, and Lamao Lima beans, pigeon peas, cowpeas, and *Tephrosia* spp., and two tests were completed. The crops of the first test were planted during the dry season and took much longer to cover the ground completely than did those of the second test which was begun in the rainy season. Of eight varieties of velvet beans tested, Black Mauritius occupied the ground for the longest period but was the latest to cover the areas efficiently. Black Mauritius was followed by Yokohama and Osceola, in the order named. Bush made the poorest cover crop of the early varieties of velvet beans. Four varieties of cowpeas gave results of practically equal value. The Patani bean ranked with the late varieties of velvet beans. *Tephrosia hookeriana* and *T. candida* are still occupying the ground. The former required a longer period to suppress weed growth than the latter, but made a much denser growth after attaining full development. The mungo bean made only a fair cover crop and for a very short time. However, it is comparatively easy to turn under for green manure. The Lamao Lima bean gives promise of becoming one of the best cover crops, because it occupies the ground for long periods and is able to keep down weed and other growth. The New Era variety of pigeon pea required more care before it was able to keep down weed growth, but also occupied the ground for a much longer period than did any of the other legumes. At the close of the year the crop was still effectively holding weed and other growth in check.

Table 3 shows the comparative efficiency in the above-mentioned tests of the different legumes as cover crops.

TABLE 3.—*Results of cover crop efficiency test*

Legume	Length of time crop required to cover ground	Length of time crop completely covered ground	Length of time crop occupied area
Planted January 25, 1924:			
Velvet beans—	*Days*	*Days*	*Days*
Osceola	62.0	96.5	158.5
Georgia	51.0	64.5	115.5
Black Mauritius	63.5	143.0	206.5
Bush	43.5	63.5	107.0
Alabama	50.5	65.0	115.5
Tracy's Early Black	54.5	61.5	116.0
Yokohama	60.5	111.5	172.0
Early Arlington	52.0	77.0	129.0
Patani beans	62.5	104.5	167.0
Cowpeas—			
Groit	58.0	68.0	126.0
Brabham	58.5	67.5	126.0
Victor	59.5	66.5	126.0
Iron	58.5	67.5	126.0
Planted February 7, 1924:			
Tephrosia hookeriana	144.0	(1)	----------
T. candida	129.0	(1)	----------
Planted January 25, 1924:			
Mungo beans—			
Black	49.5	55.0	104.5
Rice	50.0	54.5	104.5
Guam	47.0	57.5	102.5
Planted June 25, 1924:			
Lamao Lima beans	76.0	121.0	197.0
Pigeon peas, New Era variety	176.0	(1)	----------

[1] Still occupying the ground at the close of the year.

AROMA

The shrub locally known as aroma (*Acacia farnesiana*) is proving a very troublesome pest on many of the open lowland areas. It grows rapidly unless checked, and forms a thicket which smothers out pasture grasses and makes the work of preparing the land for cultivation both difficult and expensive. The only locally known method of eradicating the pest is that of thoroughly digging out the roots. In an attempt to devise more simple and less expensive methods of destroying aroma, the station treated five series of four plants each with various chemicals, including an arsenical preparation, carbon bisulphide, formalin, and carbolic and sulphuric acids. The shrubs tested were well grown, with trunks about 2 inches in diameter at the base. The arsenical preparation was made by boiling caustic soda (one-half pound) and white arsenic (1 pound) in water (1 gallon) until thoroughly dissolved and adding pine tar (1 pint) to the mixture. The solution was then boiled slowly for about 15 minutes and diluted with water (3 gallons) before using. A pint of the arsenical preparation poured into notches cut around the trunk of each shrub resulted in the death of 50 per cent of the lot, and a half pint applied to each of 12 newly sprouted stumps killed 75 per cent of the plants so treated. Carbon bisulphide, used at the rate of 1, 2, 3, and 4 fluid ounces, respectively, per shrub, was poured into shallow holes in the ground immediately surrounding the trunks. The 4-ounce application killed 25 per cent of the lot treated, but the lighter applications gave no results. Formalin, carbolic acid, and sulphuric acid, applied like the carbon bisulphide, gave negative results.

TREATMENT OF NEWLY BROKEN GRASSLANDS

Five crops have been harvested in the experiment begun in December, 1922, to determine the best method of treating newly broken native grasslands. Of the various treatments applied, barnyard manure gave the highest yield of both grain and forage. The plat receiving lime came next, and that treated with sulphur ranked third in grain yield, but fourth in forage yield. The plat to which green manure was applied produced the least quantity of forage, but gave a higher yield of grain than the check plat. Table 4 gives the results of the test:

TABLE 4.—*Effect of fertilizers on yield of corn and shallu grown on newly broken grasslands*

Treatment per acre	Estimated acre-yield of corn in 2 cuttings		Estimated acre-yield of shallu in 3 cuttings		Total yield of grain	Total yield of forage
	Grain	Forage	Grain	Forage		
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Check (no treatment)	725.63	2,160	2,008.13	19,170	2,723.76	21,330
Barnyard manure, 10,000 pounds	2,356.88	5,985	4,494.38	25,740	6,851.26	31,725
Lime, 2,000 pounds	1,032.50	2,520	3,048.75	25,470	4,081.25	27,990
Sulphur, 1,000 pounds	1,355.63	3,240	2,143.13	17,640	3,498.76	20,880
Green manure, 2,000 pounds	1,136.25	3,510	2,019.38	16,920	3,155.63	20,430

ROTATION VERSUS CONTINUOUS CULTURE

Eight crops have been obtained in the corn and legume rotation experiment begun in November, 1920. Generally two crops were planted during each year, one during the dry season, and the other during the rainy season. The two rotated plats of corn, representing eight seasons' work, yielded 22.5 per cent more grain and 26.1 per cent more forage than the unrotated plats. Cowpeas rotated with corn and velvet beans produced 68.3 per cent more grain and 53.8 per cent more forage than did the cowpeas grown in continuous culture. The rotated plats of velvet beans gave an increased yield of 71.8 per cent grain and 35.4 per cent forage over the unrotated plats. The corn crop was severely damaged by the corn borer and the corn earworm. The plats were on a friable loamy soil. The very heavy clay lowland soils would probably be benefited to an even greater extent by green manure rotation.

ROOT CROPS

Sweet potatoes (*Ipomoea batatas*).—Grown during the rainy or "off-season," the sweet potato crop made rather low yields. Of the imported varieties, Nancy Hall produced the highest yield, followed by Pumpkin. Yellow Jersey made the lowest yield. Excluding Yap, the local varieties developed foliage mostly and only an insignificant number of roots. The imported varieties gave the following estimated acre yields: Nancy Hall, 4,992 pounds; Pumpkin, 4,836 pounds; Porto Rico, 3,744 pounds; Strassburg, 1,716 pounds; Southern Queen, 1,560 pounds; Triumph, 1,092 pounds; Big Stem Jersey, 936 pounds; and Yellow Jersey, 780 pounds. The variety Yap, which produced 2,028 pounds, would take fourth place in point of yield were it considered with the imported varieties. It is, however, of inferior quality, even among the various native potatoes.

In the work begun last year to determine the effect of fertilizers on yield of sweet potatoes, acid phosphate and manure in combination in this year's test produced 10,452 pounds of roots; acid phosphate and sulphate of ammonia, 5,460 pounds; acid phosphate, nitrate of soda, and sulphate of potash, 4,680 pounds; acid phosphate, nitrate of lime, and sulphate of potash, 4,368 pounds; acid phosphate and sulphate of potash, 4,212 pounds; and acid phosphate and nitrate of lime 468 pounds, or 33.3 per cent less than the check plat. All plats in this test were planted with the variety Porto Rico.

Yam (*Dioscorea spp.*).—The yam variety and cultural test, begun in December, 1923, to determine the effect of trellising on yield, was completed during the year. In all instances the trellised plats yielded considerably more than the untrellised. Trellised plats of the Red yam variety yielded five times as many roots as the untrellised, or an increase per acre of 399.71 per cent. The White yam made an increase of 187.96 per cent by trellising, Haya 121.59 per cent, Thorny Wild 74.74 per cent, and Thornless Wild 54.16 per cent.

FRUIT INVESTIGATIONS

Recently introduced economic plants include the pejibaye palm (*Guilielma utilis*), yerba mate or Paraguay tea (*Ilex paraguayensis*), pistachio nut (*Pistachia chinensis*), and the tung-oil nut (*Aleurites fordii*). A few of the plants were distributed and the rest were

planted at the station. One of the royal palms (*Oreodoxa regia*), planted at the station in 1911, fruited for the first time. Sufficient propagating material of the palm was obtained for distribution to those requesting it. Two other royal palms were beginning to flower by the close of the year.

Orchard.—A number of new accessions were planted in the orchard, which is entirely inadequate to take care of the various introductions. It is planned to extend the area of the orchard during the coming year.

Nursery.—The Saipan variety of mango and the citrus trees which were planted in the nursery reached an age for budding and grafting. The work with citrus was done with little difficulty, but that with mangoes did not prove to be so easy. Of the several methods tried, a modified form of bottle grafting gave the best results. Over 200 citrus trees and about 50 mango trees had been successfully grafted at the close of the year. Most of the grafted trees will be distributed to farmers in the hope of stimulating local interest in fruit growing.

GARDEN-VEGETABLE DEMONSTRATIONS

In the garden-vegetable demonstration work, various kinds of vegetables were grown to learn their adaptability to Guam conditions, tests were made to ascertain the effect of copra meal as a fertilizer on the yield of beans, and various methods were tried for control of diseases affecting cucurbits.

Cabbage.—The Wong Bok variety of Chinese cabbage is proving to be admirably adapted to local conditions and seed of the crop is very much in demand. Heretofore seed of a plant closely resembling Chinese cabbage had been obtained from Japan and the supply could not always be depended upon. During the year the station obtained seed of the Chinese cabbage from the States, and it is very likely that seed from this source will take the place of the supplies usually ordered from China or Japan.

Fertilizer test.—One application of copra meal was made to plats of Kentucky Wonder beans at the rates of 1,000 and 800 pounds per acre, and to a plat of Short Fijole at the rate of 600 pounds per acre. The plat treated at the rate of 1,000 pounds per acre yielded twice as many beans as the check plat, or approximately 2,030 pounds per acre; whereas, the plat treated at the rate of 800 pounds per acre produced 92.3 per cent more beans than the check plat, or approximately 1,450 pounds per acre. The plat receiving copra meal at the rate of 600 pounds per acre produced only 11.6 per cent more beans than the check plat, or approximately 2,784 pounds per acre.

CONTROL OF DISEASES OF CUCURBITS

Of the several diseases of cucurbitaceous plants encountered during the year, none did more damage than powdery and downy mildew. Bordeaux mixture proved to be the most efficacious of the several control measures tried. Muskmelon vines were killed by sulphur-dust application, which apparently did not affect either cucumber or squash vines. The plants were sprayed immediately before reaching the vining stage, and once a week thereafter. The estimated acre yields of cucumbers with the different treatments were as follows: Bordeaux mixture 30,612.5 pounds, sulphur 22,712.5 pounds, check plat 18,612.5 pounds, and powdered lime 8,900 pounds.

SEED AND PLANT DISTRIBUTION

Many more plants but fewer seeds were distributed during the year than last year. Approximately 1,000 packages of vegetable seed were sold to the general public at cost, and 289 packages and 48 pounds of vegetable seed and 30 pounds of grass seed were furnished free of charge to the schools and other government departments. The general distribution of seeds and plants imported or grown by the station included 225 packages of vegetable seed, 2,542 lettuce plants, 640 papaya plants, 3,039 pepper plants, 637 tomato plants, 891 eggplants, 37 Isabella grapevines, 9 pejibaye palms, 30 avocado seedlings, 15 chico plants, 107 mabolo plants, 396 miscellaneous economic plants, 1,373 ornamental plants, 10 sacks of grass roots, and several hundred cuttings of introduced varieties of sweet potato.

REPORT OF THE ENTOMOLOGIST

By S. R. Vandenberg

COCONUT SCALE

The entomologist brought to Guam in March, 1925, a number of ladybird beetles (*Lindorus lopanthae*) as a means of controlling the coconut scale (*Aspidiotus destructor*). The four or five beetles surviving the trip from San Francisco were placed in a makeshift breeding cage with coconut seedlings infested with the scale as food, and immediately began feeding upon the scale. After about a week, however, they disappeared over night as the result of an incursion of red ants.

A fairly accurate and complete survey of the scale situation was made by the entomologist, working in cooperation with the insular patrol, notwithstanding the lack of adequate and dependable transportation facilities. The pest was discovered in the northwestern part of the island, whence it spread south and then east where infestation was slight. In fact, the greater the distance from the original infested area, the slighter was the chance for infestation. A study of available records and present conditions shows that the scale existed in Guam as far back as 1911, or perhaps earlier, and that it was held in check by natural enemies introduced with it. Evidently the beneficial insects were greatly reduced in number during the last two years, or conditions arose greatly favoring the rapid multiplication of the scale, since it was found in small but widely separated areas the day following the report to the station of its presence in Guam. The news caused considerable consternation and apprehension, for the pest was known to have ravaged the neighboring islands of Yap and Saipan, killing 70 to 80 per cent of the trees, the remaining trees yielding few or no nuts. Notwithstanding the establishment of rigorous quarantine regulations, the scale probably spread by the transportation of coconut leaves for thatching from one area to another, by work and grazing animals, by birds, rats, and to a certain extent by the wind.

Some of the other important host plants of *Aspidiotus destructor* include the breadfruit, papaya, banana, avocado, mango, guava, royal palm, lemon, orange, cassava, coffee, tomato, eggplant, taro, and many weed and brush plants.

Brief Life History of the Scale

Aspidiotus destructor is one of the diaspine or armored scales to which the San José (*A. perniciosus*) is related. The newly hatched larvae move about for a short time only and usually go but a short distance, whereupon they settle down on the underside of the leaf and begin feeding and excreting a hard protective covering which forms the scale proper. After the first molt the female loses her legs, antennae, and eyes. After the last molt the male emerges as a minute delicate two-winged fly, mates with the female, which is about one-third grown, and dies. The female when fully grown lays 60 to 80 eggs. Her body is surrounded with eggs which remain under her protection and hatch within a few days. The young crawl from under the edge of the scale and seek an unoccupied place on the leaf to complete their life cycle.

The scale can be found in all stages of development in any locality at any time. Apparently there is no correlation between season of year and occurrence of the pest. The average variation in the monthly mean temperature for the last seven years was less than 3° F., and there is comparatively little difference in the relative humidity of the wet and the dry season.

Control

Three important enemies of the coconut scale have been found in Guam. The first in importance is a small ladybird beetle, identified by W. Schultze of the Philippine Bureau of Science as *Cryptogonus orbiculus* var. *nigripennis*. The other two are hymenopterous parasites, the golden chalcid (*Aphelinus diaspidis*) and a smaller and less numerous parasite which attacks the male scale only and is thought to be a form of *Aspidiotiphagus citrinus*. The ladybird beetle was found to have a wide distribution, and, in conjunction with the emergency control measures of a year ago, seemed to bring the scale under contro' in certain districts in the northern part of the island. If the beetle is present in these districts it exists in numbers too small to check the new infestation. The golden chalcid is in evidence, however, and together with the judicious and timely help of man will probably bring the scale under control, Other natural enemies are to be introduced and bred for distribution for scale control throughout the island.

Spraying experiments also are to be conducted for scale control, but will necessarily have to be limited in scope because of the presence on the island of beneficial insects, the height of the coconut palms, and the inaccessibility of a large number of infested areas to spray equipment other than knapsack or barrel sprayers.

OTHER IMPORTANT INSECT PESTS

So far as can be ascertained, there was no concerted attempt to prevent the entry of insect pests into Guam during the Spanish régime, and even during a number of years following the American occupation. Many of the pests were brought in by the ancient islanders from oriental countries and by ships and Spanish galleons from Europe and the Americas. Among the foremost pests are the European corn borer (*Pyrausta nubilalis*), which has taken as high as 50 per cent of the corn crop, the sugar cane borer (*Rhabdocnemis obscurus*), which also attacks the coconut palm, the rice bug of

India (*Leptocorisa vericornis*), which has at different times ruined the rice crop, and at least five species of mealybugs which do considerable damage in the aggregate. Each of these pests would become a potential enemy were it suddenly to increase and spread

FIG. 13.—Advanced stage of coconut bud rot

as has happened elsewhere. This is true also of a great many other plant pests which taken individually are no menace but collectively form an important factor to be reckoned with in holding back the agricultural progress of the island.

COCONUT BUD ROT

Five cases of bud rot, a dreaded disease of the coconut, were discovered in Guam during the year, and drastic measures, including cutting and burning the upper parts of infested trunks and rubbish immediately surrounding them, were resorted to for control. In its early stage the disease is characterized by the dying and falling over of the crown shoot and emerging leaves, while the middle and lower whorls of leaves remain green and apparently in good condition (fig. 13). The dead shoot and leaves readily separate from the trunk, and upon examination show at the base a rotted condition accompanied by the usual offensive odor. As the disease progresses the leaves continue to die and fall over, hanging tips downward, until ultimately the whole tree succumbs. With the death of the crown shoot, or growing point, the tree is destroyed.

Nearly three months have elapsed since the last case of bud rot was discovered, and it is hoped that the disease has been effectively suppressed.

METEOROLOGICAL OBSERVATIONS, 1924–25

Observations at the station on temperature, precipitation, and wind are summarized in Table 5.

TABLE 5.—*Condensed meteorological data for the year ended June 30, 1925*

Month	Temperature					Total precipitation	Prevailing direction of the wind
	Maximum	Minimum	Mean maximum	Mean minimum	Monthly mean		
1924 [1]	°F.	°F.	°F.	°F.	°F.	*Inches*	
July	88.5	74.0	86.19	75.64	80.91	13.59	South.
August	89.5	73.0	87.46	76.05	81.75	10.06	East.
September	91.0	74.0	87.96	76.17	82.06	7.75	Northeast.
October	89.5	72.5	86.08	75.22	80.65	25.98	Do.
November	89.5	73.0	86.87	75.92	81.39	10.44	East.
December	89.5	73.0	87.62	75.86	81.74	3.30	Northeast.
1925							
January	90.0	69.5	87.41	74.22	80.81	1.14	Do.
February	90.0	70.0	87.81	73.72	80.76	.82	Do.
March	91.0	72.0	89.21	75.42	82.31	.75	East.
April	91.0	71.5	88.95	76.30	82.62	1.20	Northeast.
May	92.0	74.0	89.58	76.28	82.93	3.60	Southeast.
June	91.0	75.0	88.63	76.75	82.69	5.72	Do.
Total						84.35	

[1] Forms July to December, 1924, not received at U. S. Weather Bureau.

The year was characterized by heavy rainfall during the rainy season, followed by a serious drought, beginning in January and extending until June. The drought was one of the most severe and prolonged since the establishment of the station.